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Cellulosic Biofuel Potential from Agricultural Residues in Thailand

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Introduction:

Feedstock type and its availability are very essential to the long term sustainability of the liquid biofuel industry. Mainly derived from food sources, Thailand is currently a key biofuel producer in Asia (Fig. 1).

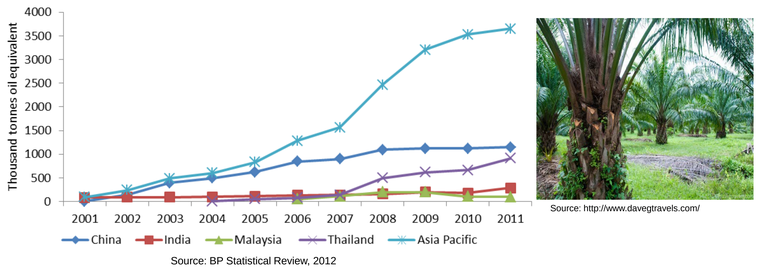

Fig. 1. Liquid biofuel production in Thailand in the Asia Pacific

Key drivers for the increased trend in biofuel production in the country includes:

- ❖ reducing import bills from transportation fuels;
- ❖ diversification of energy resources; and
- ❖ policies such as the Alternative Energy Development Plan (AEDP). In relation to biofuels, the current 10-year AEDP has a target of substituting 44% of total fossil fuel consumption for transport fuel with biofuels (Fig 2).

The growing trend in food based biofuels seem to be of concern for both local and global food supplies. This is because Thailand is a major exporter of food such as rice, sugar, corn and palm oil, globally. Therefore food security concerns coupled with environmental concerns have led to interest in feedstock alternatives including agricultural residues.

Objective:

The objective of this study was to understand the role that sustainably extracted agricultural residues could play in achieving national demand for transportation fuels and the AEDP targets.

Method:

Using methods developed by FAO and IEA, this paper estimated per annum residue amounts from Thailand's agricultural production. It applied sustainable extraction of residues and additionally, estimated the corresponding amount of liquid biofuels (i.e. bioethanol and biomass to Fischer-Tropsch diesel) that could potentially be produced.

Acknowledgement:

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Results and Discussions:

There appear to be more interest in biodiesel production recently compared to ethanol which is likely to change to correspond with proportions in the AEDP targets (Fig. 2).

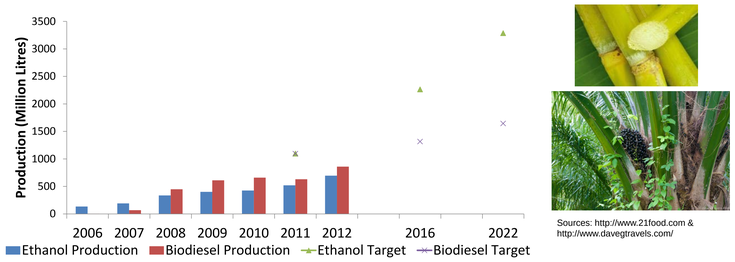

Fig. 2. Biofuel production in Thailand and the 15-year AEDP target

Although the biofuel production seem to be increasing over time due to the growing numbers in biorefinery establishment and capacities (Table 1), the amounts however falls short of the stipulated AEDP targets. For example, only 60% of the stipulated biodiesel production and 39% of ethanol respectively were achieved in year 2011 (Fig.2). This is likely to continue unless there are policy adjustments and/or alternative feedstock considerations.

Year	No. of approved/registered ethanol plants			No. of approved/registered biodiesel plants		
	No. of bio-refineries	Combined production capacity (million liters/day)	Capacity in use (%)	No. of bio-refineries	Combined production capacity (million liters/day)	Capacity in use (%)
2006	5	0.78	48	3	0.6	1
2007	7	0.96	54	5	1.3	14
2008	11	1.6	58	9	2.3	53
2009	11	1.7	65	14	5.4	31
2010	19	2.9	40	13	5.4	34
2011	19	2.9	50	13	5.4	32
2012	21	3.7	51	13	5.4	44

Table 1. Number of registered biofuel plants in Thailand since 2006

Source: Preechajarn & Prasertsri, 2012

Even though residues seem to be preferred option there however exist competing utilization for other purposes including nutrient recycling, animal fodder and other energy applications. Edapho-climatic studies are required to determine the exact amount of residue extraction in any particular location.

Our findings show that 10.4 million bone dry tonnes (bdt)/year of residues to be potentially available for liquid biofuel production (based on an estimated 20% sustainable residue removal rate). This has the potential of producing 1.14 - 3.12 billion litres per year of ethanol sufficient to offset 25% - 69% of national consumption of gasoline for transportation fuel in 2011 (Table 2).

Results and Discussions (contd.):

Alternatively, the same amount of residue could provide 0.8 - 2.1 billion liters per year of diesel (biomass to Fischer-Tropsch diesel) to potentially offset 6% - 15% of national diesel consumption in the transportation sector for that same year (Table 2).

Source	Food (tonnes/ year)	(RPR)	Residue (dry tonnes/ year)	Residue. 20% (dry tonnes/ year)	Biochemical ethanol (million litres/ year)		Biomass to Fischer Tropsch diesel (million litres/ year)	
					Low	High	Low	High
Maize	4.45E+06	1.5	5.68E+06	1.14E+06	125	341	85.2	227
Rice	3.16E+07	1.5	4.03E+07	8.06E+06	886	2,420	604	1610
Sorghum	5.40E+04	2.6	1.20E+05	2.41E+04	2.65	7.22	1.8	4.81
Sugarcane	6.88E+07	0.3	5.16E+06	1.03E+06	114	310	77.4	206
Wheat	1.10E+03	1.2	1.12E+03	2.24E+02	0.0247	0.0673	0.0168	0.0449
Cocoa	7.63E+02	1	6.49E+02	1.30E+02	0.0143	0.0389	0.0097	0.0259
Coconut	1.30E+06	0.6	7.01E+05	1.40E+05	15.4	42.1	10.5	28
Coffee	4.90E+04	2.1	8.74E+04	1.75E+04	1.92	5.24	1.13	3.5
Total				**1.04E+07**	**1,140**	**3,120**	**781**	**2,080**

Table 2. Estimated technical potential of cellulosic biofuel production from agricultural residues

This amount of sustainably derived residues could provide between 104% - 285% of Thailand's bioethanol target in the AEDP (year 2011) (Table 3). Similarly, between 71% - 190% of AEDP's biodiesel target could be met for that same year from the same amount of agricultural residues (Table 3). Therefore increasing food production could also have possible positive implications of providing feedstock sufficient to achieve AEDP biofuel targets to significant extent.

	Feedstock (dry million tonnes/year)	Bioethanol production (million litres/year)	Corresponding AEDP - bioethanol (%)	Biomass to F-T diesel production (million litres/year)	Corresponding AEDP - biodiesel (%)
Agricultural residues	10.4	1,140-3,120	25.1-68.5	800 -2,100	5.7-15.1

Table 3. Estimated cellulosic biofuel potential in relation to Thailand's AEDP target (year 2011)

Conclusion:

- ❖ Biofuels from agricultural residues presents an opportunity in the food-energy nexus and to addressing issues on food insecurity, modern energy provision and environmental damage from crude oil.
- ❖ These residues could potentially meet at least 104% (bioethanol) and 71% (biodiesel) of the AEDP (2011) targets.
- ❖ More investments in research, development, demonstration and deployment would be required to overcome existing barrier to second generation liquid biofuels.